Stenting of PDA as an alternative to Blalock-Taussig shunt

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CardioEgypt, Cairo, 2010

Small pulmonary arteries may need additional source of blood supply
Complications of Blalock-Taussig shunts

*Early*

- Death
- Bleeding
- Shunt occlusion
- Unilateral pulmonary oedema
- Seroma
- Phrenic nerve injury
- Upper limb ischaemia
- Forequarter gangrene

**UKCCCAD data for BT shunts**

*National n = 613*

<table>
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<tr>
<th>Year</th>
<th>2000/01</th>
<th>2001/02</th>
<th>2002/03</th>
<th>2003/04</th>
<th>2004/05</th>
<th>2005/06</th>
<th>Totals</th>
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<tbody>
<tr>
<td>Evelina</td>
<td>7.69%</td>
<td>11.76%</td>
<td>0.00%</td>
<td>9.09%</td>
<td>5.88%</td>
<td>13.33%</td>
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<tr>
<td>National</td>
<td>11.50%</td>
<td>9.90%</td>
<td>6.30%</td>
<td>9.00%</td>
<td>7.40%</td>
<td>8.40%</td>
<td>8.75%</td>
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30 day mortality arterial shunts
Immediate complications

Shunt occlusion

- Incidence of shunt occlusion is not well known
- Catheter treatment of stenosed or occluded BT shunts – has been reported in literature since 1980s, since advent of interventions

Shunt occlusion

treated by balloon dilation

Fig. 2. The totally occluded Blalock-Taussig shunt.

Fig. 3. Good flow is seen across the shunt after emergency balloon angioplasty.
Shunt occlusion

- Emergent stent placement for acute Blalock-Taussig shunt obstruction after stage 1 Norwood surgery

4 months later

Immediate complications

Diaphragmatic paralysis

- Incidence of diaphragmatic paralysis after cardiac surgery 5.4%
- Trend towards higher incidences of diaphragmatic paralysis observed after:
  - Arterial switch operation 10.8%
  - Fontan procedure 17.6%
  - Blalock-Taussig shunt 12.8%

Ana L. Joho-Arreola et al
Limb ischaemia


Immediate complications

Forequarter gangrene

- Fore quarter gangrene: complication of Blalock Taussig Shunt
  Raheel Hussain, Yahya Al-Faraidi.

- Pre-term (34 week) baby, birth weight 1.7 kg with critical pulmonary stenosis, VSD and PDA
Late complications

- Seroma formation
- Distortion of pulmonary artery
- Differential PA growth
- Shunt stenosis
- Calcification of shunt
- Innominate artery steal
- Differential forelimb growth
- Pseudo aneurysms

Late complications

Pseudoaneurysm formation

- An infected pseudoaneurysm following a modified Blalock-Taussig shunt

Blalock-Taussig shunt related pulmonary artery stenoses

Stenting the arterial duct

Rationale

- To secure pulmonary blood supply – as alternative to B-T shunt
  - Pulmonary atresia
  - Pulmonary stenosis with small RV
  - Other duct-dependent pulmonary circulation
PDA stenting

PA+IVS, critical PS
Integral part of RF valvotomy and balloon dilatation in patients with small RV

Other cyanotic CHD (RVOT remains obstructed)
TOF with PA, TGA VSD PA, single ventricle PA
PDA STENTING AS PRIMARY PROCEDURE

Alwi M, IJN, Kuala Lumpur

Stenting of PDA

Technique

Over a guidewire circuit

• Antegrade femoral venous approach
  – In pulmonary atresia/IVS or PS with small RV
• Retrograde arterial approach
  – The above or in tetralogy of Fallot

Without a guidewire circuit

• Retrograde arterial approach
  – Femoral artery
  – Axillary artery
Stenting of PDA

*Technique*

Over a guidewire circuit

- Antegrade femoral venous approach
  - In pulmonary atresia/IVS or PS with small RV

Stent passed through guiding sheath
Stenting of PDA

**Technique**

Over a guidewire circuit

- Antegrade femoral venous approach
  - In pulmonary atresia/IVS or PS with small RV

Stent passed without guiding sheath
Stent implantation in arterial duct
Pulmonary valve atresia/IVS

Pre RF  Post RF  After Corinthian stent in duct

Stenting of PDA

Technique

Over a guidewire circuit

- Retrograde arterial approach
  - In tetralogy of Fallot
Stenting of PDA

Technique

Over a guidewire circuit

• Retrograde arterial approach
  – In tetralogy of Fallot

Stenting of PDA

Technique

Without a guidewire circuit

• Retrograde arterial approach
  – Femoral artery
  – Axillary artery
Tricuspid atresia, PDA

PDA stenting via femoral artery route

Stenting of PDA

Technique

Without a guidewire circuit
- Retrograde arterial approach
  - Femoral artery
  - Axillary artery
PDA stenting
Pulmonary atresia/IVS – previous RF and PDA stent
6 months later, severe RVOTO and stent neointima

Ductal stenting
In duct-dependent pulmonary circulation

51
Successful stent implantation

48 survivors
3 mortality
(2 in-hospital, 1 late)

39 (81.2%)
Widely patent stent

8 (16.7%)
Stent stenosis/inadequate PDA flow
(6 in-stent stenosis, 2 stenosis at unstented PDA)
(BT shunt 3, Re-stenting 2 Balloon dilatation 3)

1 (2.1%)
Blocked stent
(BT shunt)

7 worsening of pre-existing branch PA stenosis
(RPA stenosis 1, LPA stenosis 6)
(BT shunt 5)

32
No branch PA stenosis

Alwi et al, J Am Coll Cardiol 200
Duct stenting

- 26 neonates, mean age 15 days
- Successful procedure in 24/26 cases
- No deaths
- Over follow up, 2/24 patients (8%) needed a systemic-to-pulmonary artery shunt
- 4/24 patients (17%) underwent stent redilation after mean of 6 months
- Balanced growth of pulmonary arteries

Santoro et al, 2008

Pulmonary artery growth
Duct stents vs BT shunts

- 15 pts had PDA stenting, 12 had BT shunt
- PA growth assessed by angiography 9 ± 4 months later

Santoro et al
Pulmonary artery growth

*PDA stent vs BT shunt*

*Santoro, yesterday*

**Uniform growth after duct stents**

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**Stenting the arterial duct: Current application**

- Stenting arterial duct in duct-dependent right heart circulation
  - Stent duct if short term patency required
  - e.g. pulmonary atresia/IVS with a borderline RV, or PVS with small to moderate RV
  - Occasional newborn with tetralogy of Fallot
- Ductal flow may progressively decrease slowly over several months by luminal narrowing
- Spontaneous closure of the stented duct well tolerated when antegrade flow present
- When closure occurs, the right ventricular size has increased and the circulation may no longer be duct-dependent
- No distortion of the branch pulmonary arteries
Stenting the arterial duct in congenital heart defects

**Conclusion**

- Ductal stenting can achieve medium term patency as an alternative to BT shunts
- Ideal solution in the patient with PA-IVS or critical PS & poor right ventricular compliance, when short term duct patency is needed
- If stents are used in ducts, close follow up required in case repeat balloon dilation is needed, especially in those in whom duct is sole source of pulmonary blood flow